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JOHN W. FLANNAGAN RESERVOIR, DICKENSON COUNTY, VIRGINIA

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

JUNE 1975

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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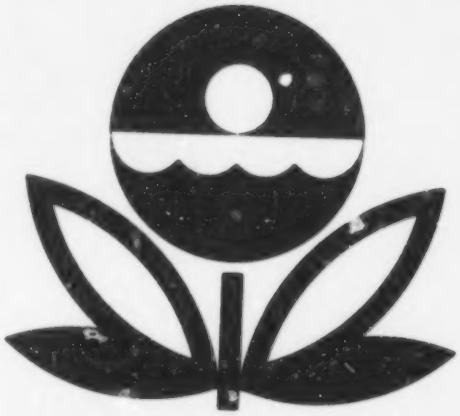

REPORT

ON

JOHN W. FLANNAGAN RESERVOIR

DICKENSON COUNTY

VIRGINIA

EPA REGION III

WORKING PAPER No. 463

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

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REPORT
ON
JOHN W. FLANNAGAN RESERVOIR
DICKENSON COUNTY
VIRGINIA
EPA REGION III
WORKING PAPER No. 463

WITH THE COOPERATION OF THE
VIRGINIA STATE WATER CONTROL BOARD
AND THE
VIRGINIA NATIONAL GUARD
JUNE, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Virginia State Water Control Board for professional involvement and to the Virginia National Guard for conducting the tributary sampling phase of the Survey.

Eugene T. Jensen, Executive Secretary of the State Water Control Board; Michael A. Bellanca, Director; Jean W. Gregory, Pollution Control Specialist; and Robert W. Pitchford, Pollution Control Technician; Bureau of Surveillance and Field Studies; provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

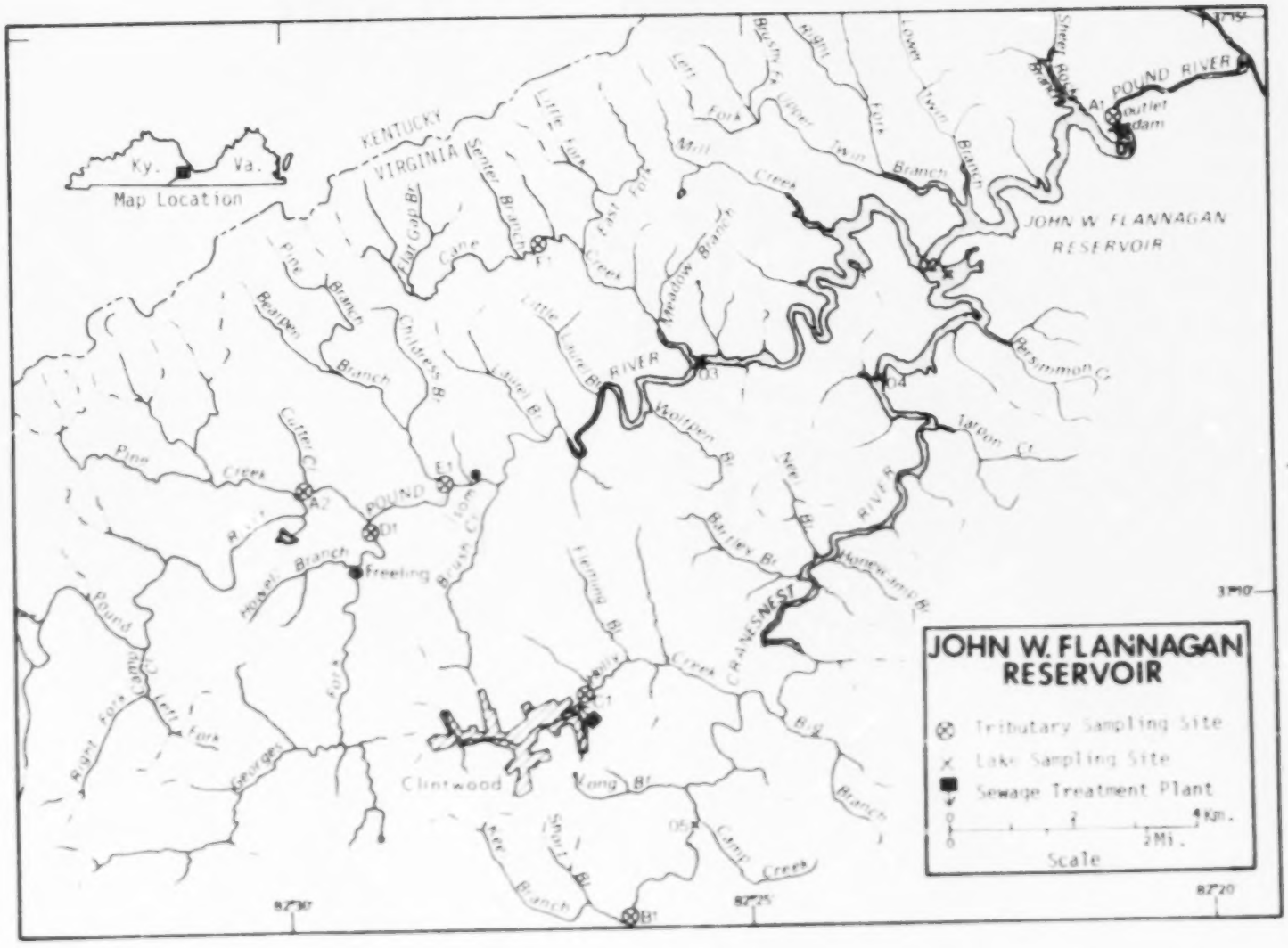
Major General William J. McCaddin, the Adjutant General of Virginia, and Project Officer Lt. Colonel James D. Manley, who directed the volunteer efforts of the Virginia National Guardsmen, also are gratefully acknowledged for their assistance to the Survey.

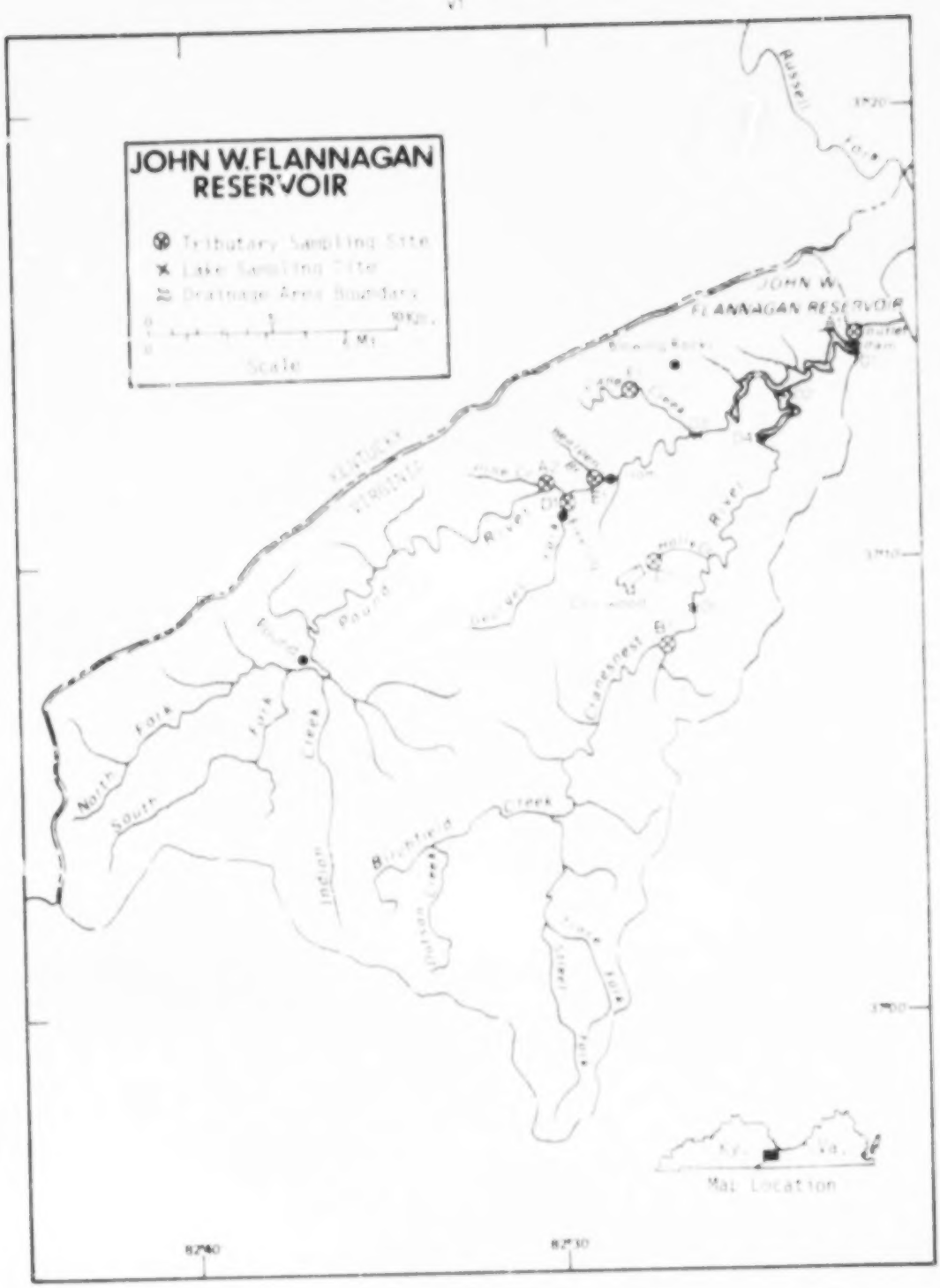
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF VIRGINIA

LAKE NAME	COUNTY
Bluestone	Giles, VA; Mercer, Monroe, Summers, WV
Chesdin	Amelia, Chesterfield, Dinwiddie
Chickahominy	Charles City, New Kent
Claytor	Pulaski
J. H. Kerr	Charlotte, Hallifax, Micklenburg, VA; Granville, Vance, Warren, NC
J. W. Flannagan	Dickenson
Occoquan	Fairfax, Prince William
Rivanna	Albemarle
Smith Mountain	Bedford, Franklin, Pittsylvania


Ky.
Va.
Map Location
KENTUCKY
VIRGINIA
JOHN W. FLANNAGAN RESERVOIR
POUND RIVER
Outlet dam
Clintwood
Freeling
Pine Creek
Right Fork Pound
Left Fork
Little Laurel Br.
Laurel Br.
Mouthpiece Br.
Barrier Br.
Honeycamp Br.
Fleming Br.
Long Br.
Camp Creek
Persimmon Cr.
Tarpon Cr.
Cutter Cr.
Georges
Pine Branch
Beartown Branch
Childress Br.
Shallow Branch
Mill Creek
Sheep Rock Branch
Lower Twin Branch
Upper Twin Branch
Right Fork
Left Fork
Big Branch
Short Br.
Rose Branch
A1
A2
B1
C1
D1
E1
F1
03
04
87°30'
87°25'
87°20'
37°15'
37°10'
JOHN W. FLANNAGAN RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Plant
0 2 4 Km.
0 2 3 Mi.
Scale


JOHN W. FLANNAGAN RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Scale
Map Location
JOHN W. FLANNAGAN RESERVOIR
Russell Fork
North Fork
South Fork
Indian Creek
Buckhorn Creek
Pound
Dismal Creek
Levisa Fork
Ky.
Va.
82°40
82°30

JOHN W. FLANNAGAN RESERVOIR

STORET NO. 5105

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that John W. Flannagan Reservoir is mesotrophic. It ranked first in overall trophic quality when the eight Virginia lakes sampled in 1973 were compared using a combination of six water quality parameters*. None of the other lakes had less median total phosphorus, median dissolved phosphorus, and median inorganic nitrogen; one had less mean chlorophyll a; and none of the others had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at stations 1 and 2 in September.

Survey limnologists did not observe surface algae or emergent vegetation.

B. Rate-Limiting Nutrient:

The algal assay results indicate that the reservoir was limited by phosphorus at the time the sample was taken (04/05/73). The lake data indicate phosphorus limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, point sources contributed an estimated 26.9% of the total phosphorus load to John W. Flannagan Reservoir. The Clintwood wastewater treatment plant contributed 13.1% of this input, and untreated wastes from

* See Appendix A.

Pound accounted for 13.8%.

The present phosphorus loading of 2.47 $g/m^2/yr$ is more than 1.5 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 14). Because the reservoir is limited by phosphorus and the loading rate is high, all phosphorus inputs should be reduced to the greatest practicable degree.

Water quality in the reservoir essentially is high as has been noted in another report (Wollitz, 1973). However, if phosphorus inputs continue at the existing rate, the reservoir eventually will become eutrophic. Therefore, phosphorus removal should be considered as a measure to prevent deterioration of the present water quality.

Previous studies on the Pound River watershed have shown that large amounts of waste from mines caused some of the tributaries of this reservoir to become highly acidic (Wheeler et al., 1970). Survey data indicate that the effect of such wastes on the reservoir was minimal at the time the samples were taken. Normal pH ranges were observed at all sampling stations.

2. Non-point sources--The phosphorus contribution of non-point sources accounted for 72.4% of the load to the reservoir. The Pound River contributed 22.2%, Cranesnest River contributed 23.3%, Holly Creek contributed 11.4%, and the remaining three gaged tributaries collectively contributed 2.8% of the total.

Ungaged tributaries were estimated to have contributed 12.7%.

The nutrient export rate of Holly Creek was very high (262 kg P/km^2/yr) as compared to the rates of the other tributaries in the reservoir watershed; e.g., Pound River (11 kg P/km^2/yr), Cranesnest River (15 kg P/km^2/yr), Georges Fork (9 kg P km^2/yr), Bearpen Branch (8 kg P/km^2/yr), and Cane Creek (9 kg P/km^2/yr). This may be indicative of other unknown point sources impacting Holly Creek or underestimation of the phosphorus load coming from the waste treatment plant at Clintwood. However, it is more likely that the Holly Creek sampling station (C-1) was so close to the Clintwood wastewater treatment plant that the effluent was not completely mixed in the stream at the sampling point; note that the mean total phosphorus concentration in Holly Creek was a very high 1.422 mg/l, but the mean total phosphorus concentration in Cranesnest River at station B-1 was only 0.040 mg/l (see map, page v).

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 4.63 kilometers^2.
2. Mean depth: 18.0 meters.
3. Maximum depth: >46 meters.
4. Volume: 83.340 x 10^6 m^3.
5. Mean hydraulic retention time: 118 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Pound River	230.3	3.3
Cranesnest River	172.5	2.5
Holly Creek	5.0	0.1
Georges Fork	20.7	0.3
Bearpen Branch	8.8	0.1
Cane Creek	7.2	0.1
Minor tributaries & immediate drainage -	123.3	1.9
Totals	567.8	8.3

2. Outlet -

Pound River	572.4**	8.2

C. Precipitation***:

1. Year of sampling: 124.1 centimeters.
2. Mean annual: 99.1 centimeters.

† Table of metric conversions--Appendix B.
†† Bellanca, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

John W. Flannagan Reservoir was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at four stations in April and September and three stations in July (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, two 18.9-liter depth-integrated samples were composited for algal assays (stations 1 and 3 were combined, and stations 4 and 5 were combined). Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll *a* analysis. The maximum depths sampled were 45.7 meters at station 1, 30.5 meters at station 2, 30.5 meters at station 3, 12.2 meters at station 4, and 6.1 meters at station 5.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR JOHN W. FLANNAGAN DAM
STORET CODE 5105

	1ST SAMPLING (4/ 5/73)			2ND SAMPLING (7/18/73)			3RD SAMPLING (9/27/73)		
	4 SITES			3 SITES			4 SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	9.5 - 128.0	16.6	11.3	10.5 - 27.8	21.4	26.7	7.1 - 24.5	19.0	21.2
DISS OXY (MG/L)	8.4 - 10.1	9.6	9.7	5.5 - 11.8	8.2	7.8	0.2 - 8.6	4.6	4.6
CNDCTVY (MCHOMO)	175. - 260.	216.	205.	131. - 362.	232.	228.	144. - 470.	262.	260.
PH (STAND UNITS)	6.5 - 7.1	6.9	7.0	6.5 - 9.8	7.6	8.1	6.3 - 7.3	6.7	6.8
TOT ALK (MG/L)	12. - 23.	17.	16.	18. - 35.	25.	24.	10. - 54.	25.	21.
TOT P (MG/L)	0.011 - 0.059	0.013	0.014	0.005 - 0.020	0.009	0.008	0.005 - 0.020	0.009	0.007
ORTHO P (MG/L)	0.002 - 0.005	0.003	0.002	0.004 - 0.009	0.005	0.005	0.003 - 0.007	0.004	0.004
NO2+NO3 (MG/L)	0.230 - 0.430	0.342	0.350	0.060 - 0.400	0.191	0.110	0.030 - 0.340	0.170	0.140
AMMONIA (MG/L)	0.020 - 0.060	0.043	0.045	0.040 - 0.090	0.059	0.050	0.030 - 0.280	0.059	0.040
KJEL N (MG/L)	0.200 - 0.500	0.271	0.200	0.200 - 0.700	0.324	0.200	0.200 - 0.800	0.305	0.200
INORG N (MG/L)	0.260 - 0.480	0.385	0.400	0.120 - 0.450	0.251	0.170	0.060 - 0.380	0.229	0.280
TOTAL N (MG/L)	0.430 - 0.890	0.613	0.550	0.290 - 0.790	0.515	0.510	0.230 - 0.850	0.475	0.480
CHLRPYL A (UG/L)	0.9 - 7.0	3.6	3.3	7.0 - 16.4	10.6	8.3	3.6 - 6.4	4.8	4.6
SECCHI (METERS)	0.6 - 0.9	0.7	0.6	3.7 - 3.7	3.7	3.7	1.3 - 4.0	2.8	3.0

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/05/73	1. Flagellates	348
	2. Dinobryon sp.	218
	3. Dinoflagellates	52
	4. Synedra sp.	26
	5. Pennate diatoms	9
	Other genera	-
	Total	653
07/18/73	1. Flagellates	1,287
	2. Peridinium sp.	308
	3. Stephanodiscus sp.	218
	4. Dinobryon sp.	109
	5. Tetraedron sp.	54
	Other genera	91
	Total	2,067
09/27/73	1. Cyclotella sp.	1,224
	2. Flagellates	577
	3. Synedra sp.	162
	4. Peridinium sp.	81
	5. Dinoflagellates	69
	Other genera	93
	Total	2,206

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/05/73	01	2.6
	02	-
	03	4.1
	04	0.9
	05	7.0
07/18/73	01	8.3
	02	7.0
	03	16.4
	04	-
	05	-
09/27/73	01	3.6
	02	3.9
	03	5.3
	04	6.4
	05	-

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. Stations 1 and 3 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.010	0.311	0.1
0.050 P	0.060	0.311	7.1
0.050 P + 1.0 N	0.060	1.311	17.7
1.0 N	0.010	1.311	0.1

b. Stations 4 and 5 -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.371	0.1
0.050 P	0.055	0.371	8.6
0.050 P + 1.0 N	0.055	1.371	17.6
1.0 N	<0.005	1.371	0.1

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of John W. Flannagan Reservoir was low at the time the samples were collected (04/05/73). Also, in both assays the significant increases in yields with the addition of orthophosphorus alone indicate that this water body was limited by phosphorus at that time. Note that the addition of only nitrogen resulted in yields which were no different than those of the controls.

The reservoir data substantiate phosphorus limitation; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 22/1 or greater at all sampling stations and times, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Virginia National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the maps (pages v and vi), except for the high runoff month of February when two samples were collected. Sampling was begun in July, 1973, and was completed in June, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Virginia District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2, B-1, D-1, E-1, and F-1 and multiplying the means by the ZZ area in km^2.

The community of Clintwood did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year. Nutrient loads from Pound, which had no treatment during the Survey sampling year, were estimated at 1.587 kg P and 4.263 kg N/capita/year.

---

* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Clintwood*	1,320	trickling filter	499.6	Holly Creek
Pound**	995	none	?	Pound River

2. Known industrial -

Name	Treatment	Mean Flow (m^3/d)	Receiving Water
Strip Mines	?	?	Pound River

* Anonymous, 1971; flow estimated at 0.3785 m^3/capita/day; pop. is 1970 Census.
** Bellanca, 1976.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Pound River	2,540	22.2%
Cranesnest River	2,665	23.3
Holly Creek	1,310	11.4
Georges Fork	190	1.6
Bearpen Branch	70	0.6
Cane Creek	65	0.6
b. Minor tributaries & immediate drainage (non-point load) -	1,455	12.7
c. Known municipal STP's -		
Clintwood	1,495	13.1
Pound	1,580	13.8
d. Septic tanks - Unknown	?	-
e. Known industrial -		
Strip mines	?	-
f. Direct precipitation* -	80	0.7
Total	11,450	100.0

2. Outputs -

Lake outlet - Pound River 3,400

3. Net annual P accumulation - 8,050 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Pound River	109,045	36.4
Cranesnest River	96,430	32.2
Holly Creek	4,710	1.6
Georges Fork	12,050	4.0
Bearpen Branch	3,235	1.1
Cane Creek	2,450	0.8
b. Minor tributaries & immediate drainage (non-point load) -	57,730	19.3
c. Known municipal STP's -		
Clintwood	4,490	1.5
Pound	4,240	1.4
d. Septic tanks - Unknown	?	-
e. Known industrial -		
Strip mines	?	-
f. Direct precipitation* -	5,000	1.7
Total	299,380	100.0

2. Outputs -

Lake outlet - Pound River 311,675

3. Net annual N loss - 12,295 kg.

* See Working Paper No. 175.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Pound River	11	473
Cranesnest River	15	559
Holly Creek	262	942
Georges Fork	9	582
Bearpen Branch	8	368
Cane Creek	9	340

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	2.47	1.74	64.7	loss*

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of John W. Flannagan Reservoir:

"Dangerous" (eutrophic loading)	1.44
"Permissible" (oligotrophic loading)	0.72

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the reservoir, solubilization of previously sedimented nitrogen recharge with nitrogen-rich ground water, or unknown and unsampled point sources discharging directly to the reservoir. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's former National Eutrophication and Lake Restoration Branch (Malueg et al., 1975).

V. LITERATURE REVIEWED

Bellanca, Michael A., 1975. Personal communication (lake morphometry). VA Water Contr. Bd., Richmond.

_____, 1976. Personal communication (Pound sewage facilities). VA Water Contr. Bd., Richmond.

Malueg, Kenneth W., D. Phillips Larsen, Donald W. Schults, and Howard T. Mercier; 1975. A six-year water, phosphorus, and nitrogen budget for Shagawa Lake, Minnesota. Jour. Environ. Qual., vol. 4, no. 2, pp. 236-242.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

Wheeler, D. R., R. S. Melvor, C. R. Berry, Joe Soukup, Ellice S. Smith, P. J. Anderson, and E. R. Arnold; 1970. A biological and chemical water quality investigation of the Pound River watershed. VA Water Contr. Bd., Richmond.

Wollitz, Robert E., 1973. Southwest Virginia stream fisheries survey. Job progress report for Virginia Dingell-Johnson Project F-22-3.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN HARMAN'S

LAKE CODE	LAKE NAME	[illegible]	[illegible]	[illegible] MEAN DEC	[illegible] CHLORA	[illegible] MIN [illegible]	[illegible] DISS [illegible]
5103	CLAYTOR LAKE	[illegible]	0.450	437.000	[illegible]	14.500	0.008
5105	JOHN W. FLANNAGAN DAM	[illegible]	0.320	415.700	5.955	14.400	0.004
5106	JOHN H. KERR RESERVOIR	0.04[illegible]	0.240	455.937	[illegible].833	15.000	0.004
5108	OCCOQUAN RESERVOIR	0.048	0.525	454.750	12.417	15.000	0.037
5110	SMITH MOUNTAIN LAKE	0.015	0.410	419.667	11.533	15.000	0.005
5111	LAKE CHESDIN	0.0[illegible]	0.240	465.778	12.556	14.800	0.008
5112	CHICKAHOMINY LAKE	[illegible].05[illegible]	0.125	455.333	13.600	[illegible].400	0.017
5113	RIVANNA (SOUTH FORK) RES	[illegible].07[illegible]	0.475	[illegible].222	[illegible].667	13.000	0.022

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN DATA	MEDIAN [illegible]	50%- MEAN	MEAN MEAN	15%- MIN	MAX MAX	INDEX
5103	CLAYTOR LAKE	[illegible]	[illegible]	71 (5)	100 (7)	43 (3)	[illegible]	378
5105	JOHN W. FLANNAGAN DAM	100 (7)	57 (4)	100 (7)	86 (6)	86 (6)	100 (7)	537
5106	JOHN H. KERR RESERVOIR	43 (3)	71 (5)	43 (3)	57 (4)	14 (0)	43 (3)	271
5108	OCCOQUAN RESERVOIR	0 (0)	0 (0)	29 (2)	29 (2)	14 (0)	0 (0)	72
5110	SMITH MOUNTAIN LAKE	86 (6)	43 (3)	86 (6)	43 (3)	14 (0)	86 (6)	334
5111	LAKE CHESDIN	57 (4)	86 (6)	0 (0)	14 (1)	86 (6)	86 (6)	285
5112	CHICKAHOMINY LAKE	29 (2)	100 (7)	57 (4)	0 (0)	100 (7)	29 (2)	315
5113	RIVANNA (SOUTH FORK) RES	14 (1)	14 (1)	14 (1)	71 (5)	86 (6)	14 (1)	213

Reproduced from best available copy.

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX
1	5105	JOHN W. FLANNAGAN DAM	507
2	5103	CLAYTOR LAKE	374
3	5110	SMITH MOUNTAIN LAKE	355
4	5112	CHICKAHOMINY LAKE	315
5	5111	LAKE CHESDIN	2[illegible]
6	5106	JOHN H. KERR RESERVOIR	271
7	5113	RIVANNA (SOUTH FORK) RES	213
[illegible]	5104	OCCOQUAN RESERVOIR	[illegible]

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR VIRGINIA 02/05/76

LAKE CODE 5105 JOHN W FLANNAGAN RESERVOIR

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 572.4

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5105A1	572.4	12.46	17.27	20.39	12.46	8.78	4.25	3.40	3.11	1.70	1.70	3.96	9.63	8.21
5105A2	230.3	5.15	6.91	8.01	5.15	4.02	1.78	1.44	1.25	0.62	0.54	1.67	3.77	3.34
5105B1	172.5	3.68	5.10	5.95	3.96	2.83	1.33	1.05	0.91	0.45	0.37	1.25	2.83	2.46
5105C1	5.0	0.08	0.14	0.14	0.11	0.08	0.06	0.02	0.02	0.01	0.00	0.03	0.06	0.06
5105D1	20.7	0.40	0.57	0.62	0.48	0.34	0.14	0.08	0.08	0.03	0.02	0.14	0.28	0.26
5105E1	8.8	0.17	0.23	0.25	0.23	0.14	0.06	0.03	0.03	0.02	0.01	0.06	0.11	0.11
5105F1	7.2	0.14	0.20	0.20	0.17	0.11	0.06	0.03	0.03	0.01	0.01	0.06	0.08	0.09
5105ZZ	127.9	2.66	3.68	4.25	2.83	2.07	0.96	0.74	0.62	0.31	0.25	2.32	2.04	1.88

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 572.4
SUM OF SUB-DRAINAGE AREAS = 572.4

TOTAL FLOW IN = 99.14
TOTAL FLOW OUT = 99.11

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
5105A1	7	73	5.10	15	1.42		
	8	73	3.06	11	1.93		
	9	73	3.06	9	1.30		
	10	73	5.32	14	4.56		
	11	73	11.78	11	1.33		
	12	73	21.69	8	4.45		
	1	74	31.43	12	0.85		
	2	74	14.44	9	11.10	22	9.15
	3	74	22.94	9	16.85	22	59.47
	4	74	7.50	20	6.29		
	5	74	10.53	11	1.50		
	6	74	14.02	9	4.87		
5105A2	7	73	3.54	15	1.10		
	8	73	1.76	11	3.31		
	9	73	0.54	9	0.40		
	10	73	1.16	14	0.59		
	11	73	7.76	11	0.91		
	12	73	7.87	8	2.61		
	1	74	14.24	12	24.61		
	2	74	0.37	8	4.36	22	8.50
	3	74	11.38	9	6.43	22	27.69
	4	74	6.80	20	3.11		
	5	74	5.49	11	3.11		
	6	74	6.88	9	2.72		

TRIBUTARY FLOW INFORMATION FOR VIRGINIA 02/05/76

LAKE CODE 5105 JOHN W FLANNAGAN RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5105B1	7	73	0.93	15	0.54				
	8	73	0.59	11	0.65				
	9	73	0.27	9	0.21				
	10	73	0.59	14	0.40				
	11	73	4.39	11	0.34				
	12	73	4.08	8	1.10				
	1	74	8.81	12	16.06				
	2	74	4.11	9	2.24	22	10.31		
	3	74	6.68	9	3.96	22	12.69		
	4	74	3.43	20	1.25				
	5	74	2.97	11	1.87				
	6	74	3.51	9	1.10				
5105C1	7	73	0.03	15	0.02				
	8	73	0.02	11	0.02				
	9	73	0.01	9	0.02				
	10	73	0.02	14	0.02				
	11	73	0.13	11	0.02				
	12	73	0.12	8	0.02				
	1	74	0.25	12	0.76				
	2	74	0.12	8	0.05	22	0.19		
	3	74	0.20	9	0.08	22	0.62		
	4	74	0.10	20	0.02				
	5	74	0.08	11	0.03				
	6	74	0.10	9	0.02				
5105D1	7	73	0.11	15	0.09				
	8	73	0.07	11	0.09				
	9	73	0.03	9	0.06				
	10	73	0.07	14	0.08				
	11	73	0.54	11	0.07				
	12	73	0.48	8	0.11				
	1	74	1.05	12	0.37				
	2	74	0.48	9	0.15	22	0.24		
	3	74	0.79	9	0.19	22	0.40		
	4	74	0.42	20	0.12				
	5	74	0.37	11	0.14				
	6	74	0.42	9	0.11				
5105E1	7	73	0.05	15	0.01				
	8	73	0.03	11	0.02				
	9	73	0.01	9	0.01				
	10	73	0.03	14	0.01				
	11	73	0.22	11	0.01				
	12	73	0.21	8	0.02				
	1	74	0.45	12	0.16				
	2	74	0.21	9	0.04	22	0.08		
	3	74	0.34	9	0.05	22	0.16		
	4	74	0.18	20	0.03				
	5	74	0.15	11	0.03				
	6	74	0.18	9	0.02				

TRIBUTARY FLOW INFORMATION FOR VIRGINIA 02/05/76

LAKE CODE 5105 JOHN W FLANNAGAN RESERVOIR

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5105F1	7	73	0.04	15	0.01				
	8	73	0.03	11	0.01				
	9	73	0.01	9	0.01				
	10	73	0.03	14	0.01				
	11	73	0.18	11	0.01				
	12	73	0.17	8	0.02				
	1	74	0.37	12	0.45				
	2	74	0.17	8	0.04	22	0.12		
	3	74	0.28	9	0.06	22	0.57		
	4	74	0.14	20	0.02				
	5	74	0.12	11	0.03				
	6	74	0.15	9	0.02				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/02/05

510501
37 13 56.0 082 20 38.0
JOHN W. FLANNAGAN DAM
51051 VIRGINIA

11EPALES
3

2111202
0100 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/05	15 50	0000	13.9		37	200	6.80	16	0.030	0.200K	0.300	0.004
	15 50	0004	13.9	9.9		200	7.00	18	0.020	0.200K	0.300	0.004
	15 50	0015	13.9	9.9		190	7.00	18	0.020	0.200K	0.300	0.003
	15 50	0030	11.4	9.6		175	7.00	17	0.060	0.200K	0.400	0.005
	15 50	0050	10.8	9.4		190	7.00	16	0.060	0.300	0.410	0.004
	15 50	0075	9.8	9.4		195	7.00	15	0.050	0.300	0.430	0.003
	15 50	0095	9.5	10.1		195	7.00	16	0.050	0.300	0.420	0.003
73/07/18	14 50	0000	27.8		144	204	8.70	19	0.060	0.400	0.110	0.005
	14 50	0005	26.9	9.4		199	8.80	19	0.050	0.200K	0.090	0.005
	14 50	0015	26.7	10.6		228	8.40	20	0.050	0.200K	0.100	0.005
	14 50	0025	21.9	11.8		180	8.10	20	0.050	0.200	0.150	0.005
	14 50	0050	15.1	8.0		160	6.90	19	0.080	0.200K	0.260	0.006
	14 50	0075	11.9	6.6		135	6.60	18	0.040	0.200K	0.360	0.005
	14 50	0100	10.9	7.0		132	6.60	21	0.050	0.200K	0.390	0.009
	14 50	0125	10.5	7.3		131	6.50	21	0.050	0.200K	0.400	0.004
73/09/27	12 50	0000	23.7	7.8	156	286	7.20	20	0.060	0.500	0.090	0.005
	12 50	0030	23.4	5.6		284	6.90	19	0.040	0.200	0.140	0.004
	12 50	0045	21.2	3.8		251	6.50	16	0.040	0.200K	0.240	0.004
	12 50	0055	18.5	5.6		206	6.50	13	0.030	0.200K	0.250	0.004
	12 50	0070	16.3	4.6		196	6.40	13	0.040	0.200K	0.270	0.004
	12 50	0100	13.7	2.8		150	6.50	10	0.040	0.200K	0.330	0.007
	12 50	0130	12.5	4.6		144	6.40	11	0.040	0.200	0.340	0.006
	12 50	0140	8.1	1.8		192	6.80	54	0.030	0.200K	0.280	0.005
	12 50	0150	7.1	1.0		192	6.80	51	0.030	0.200K	0.280	0.005

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/05

510501
37 13 56.0 082 20 38.0
JOHN W. FLANNAGAN DAM
51051 VIRGINIA

11EPALES 2111202
3 0100 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/05	15 50	0000	0.015	2.6
	15 50	0004	0.013	
	15 50	0015	0.013	
	15 50	0030	0.055	
	15 50	0050	0.059	
	15 50	0075	0.031	
	15 50	0095	0.031	
73/07/18	14 50	0000	0.009	8.3
	14 50	0005	0.006	
	14 50	0015	0.007	
	14 50	0025	0.010	
	14 50	0050	0.006	
	14 50	0075	0.005	
	14 50	0100	0.009	
	14 50	0125	0.005	
73/09/27	12 50	0000	0.011	3.6
	12 50	0030	0.009	
	12 50	0045	0.008	
	12 50	0055	0.007	
	12 50	0070	0.006	
	12 50	0100	0.009	
	12 50	0130	0.006	
	12 50	0140	0.005	
	12 50	0150	0.006	

STORET RETRIEVAL DATE 76/02/05

510502
37 12 48.0 082 22 36.0
JOHN W. FLANNAGAN DAM
51051 VIRGINIA

IIEPALES
3

2111202
0095 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/07/18	15 30	0000	27.6		144	271	8.30	29	0.060	0.500	0.100	0.006
	15 30	0005	27.3	8.8		266	8.30	30	0.050	0.300	0.080	0.005
	15 30	0015	26.8	9.6		362	8.10	32	0.050	0.300	0.110	0.006
	15 30	0025	21.7	7.5		300	7.10	35	0.090	0.400	0.210	0.005
	15 30	0055	15.4	5.5		244	6.70	30	0.050	0.200	0.310	0.004
	15 30	0080	12.1			187	6.50	24	0.070	0.200K	0.370	0.004
73/09/27	14 50	0000	24.1	7.9	144	293	7.30	21	0.050	0.400	0.080	0.004
	14 50	0030	21.2	3.8		332	6.80	25	0.050	0.200K	0.100	0.004
	14 50	0050	20.0	1.4		260	6.40	21	0.040	0.200K	0.240	0.004
	14 50	0065	16.4	2.6		184	6.30	15	0.040	0.200K	0.320	0.004
	14 50	0085	15.0	0.4		224	6.40	20	0.070	0.200K	0.260	0.004
	14 50	0100	14.4	0.2		240	6.60	43	0.280	0.500	0.040	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/07/18	15 30	0000	0.008	7.0
	15 30	0005	0.006	
	15 30	0015	0.011	
	15 30	0025	0.009	
	15 30	0055	0.005	
	15 30	0080	0.006	
73/09/27	14 50	0000	0.006	3.9
	14 50	0030	0.006	
	14 50	0050	0.006	
	14 50	0065	0.006	
	14 50	0085	0.006	
	14 50	0100	0.009	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/05

510562
37 12 06.0 082 25 10.0
JOHN H. KERR RESERVOIR DAM
51051 VIRGINIA

AIRPLANES
3

2111202
0100 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00095 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/05	15 50	0000	12.0		24	190	6.90	16	0.040	0.200	0.370	0.002
	15 50	0005	12.7	9.8		190	6.70	16	0.030	0.200K	0.400	0.002K
	15 50	0015	12.5	9.8		190	6.50	15	0.030	0.200K	0.330	0.002K
	15 50	0025	11.6	9.5		175	7.10	16	0.040	0.400	0.340	0.002K
	15 50	0040	11.1	9.4		180	7.10	15	0.050	0.500	0.380	0.002K
	15 50	0060	10.5	9.4		220	7.00	15	0.050	0.500	0.390	0.002K
	15 50	0080	9.9	9.5		210	7.00	12	0.050	0.400	0.390	0.002K
	15 50	0100	9.6	9.6		235	7.00	13	0.060	0.400	0.370	0.002K
73/07/18	16 15	0000	27.6	6.6		320	8.30	32	0.080	0.700	0.090	0.008
	16 15	0005	27.2	7.8		320	8.10	31	0.060	0.700	0.060	0.005
	16 15	0015	26.9	7.9		302	7.60	32	0.070	0.400	0.060	0.006
73/09/27	14 30	0000	23.9	7.8	50	318	7.20	22	0.050	0.700	0.030	0.004
	14 30	0010	23.5	8.4		311	6.80	26	0.030	0.300	0.030	0.003
	14 30	0018	21.7	4.6		470	6.70	43	0.120	0.300	0.080	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/05	15 50	0000	0.011	4.1
	15 50	0005	0.014	
	15 50	0015	0.012	
	15 50	0025	0.017	
	15 50	0040	0.021	
	15 50	0060	0.014	
	15 50	0080	0.014	
	15 50	0100	0.012	
73/07/18	16 15	0000	0.019	14.4
	16 15	0005	0.009	
	16 15	0015	0.020	
73/09/27	14 30	0000	0.017	5.3
	14 30	0010	0.012	
	14 30	0018	0.020	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/05

510504
37 11 55.0 082 23 25.0
JOHN W. FLANNAGAN
51051 VIRGINIA

11EPALES
3

2111202
0044 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/05	16 40	0000	12.7		24	260	7.00	23	0.040	0.200K	0.350	0.002K
	16 40	0006		9.4		250	7.00	23	0.040	0.200K	0.350	0.002
	16 40	0015	12.3	9.3		235	7.00	22	0.050	0.200K	0.350	0.005
	16 40	0025	11.7	9.2		250	6.90	21	0.050	0.200K	0.350	0.002
	16 40	0040	11.3	8.4		260	6.80	19	0.050	0.200K	0.350	0.002K
73/09/27	16 25	0000	24.5	8.0	96	320	7.10	30	0.070	0.800	0.050	0.005
	16 25	0015	23.8	8.6		321	7.00	29	0.030	0.200	0.030	0.004
	16 25	0030	23.2	7.6		338	7.00	32	0.060	0.300	0.040	0.004

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/05	16 40	0000	0.014	0.9
	16 40	0006	0.011	
	16 40	0015	0.013	
	16 40	0025	0.015	
	16 40	0040	0.013	
73/09/27	16 25	0000	0.012	6.4
	16 25	0015	0.007	
	16 25	0030	0.011	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/02/05

510505
37 08 08.0 082 25 36.0
JOHN W. FLANNAGAN DAM
51051 VIRGINIA

11EPALES
3

2111202
0024 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/05	16 40	0000	11.1		24	250	6.90	16	0.050	0.200	0.240	0.004
	16 40	0004	11.1	10.0		250	7.00	17	0.040	0.200	0.230	0.003
	16 40	0015	11.1	10.0		250	7.00	17	0.040	0.300	0.230	0.003
	16 40	0020	11.1	10.0		245	7.10	18	0.030	0.300	0.230	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/05	16 40	0000	0.015	7.0
	16 40	0004	0.014	
	16 40	0015	0.013	
	16 40	0020	0.015	

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 73/03/26

21VSA1
37 14 05.0 082 20 44.0
POUND RIVER
21155 7.5 HAYSI
0/JOHN W. FLANNAGAN RES.
BELOW DAM APPR 3.5 MI N OF PUCKETT GAP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	13 30		0.390	0.630	0.044		0.010
73/08/11	13 30		0.330	1.100	0.060	0.005K	0.010
73/09/09	11 30		0.231	2.310	0.200	0.005K	0.005K
73/10/14	12 00		0.220	0.500	0.094		0.005K
73/11/11	13 20		0.160	0.930	0.052	0.005K	0.030
73/12/05	12 05		0.300	1.100	0.076	0.008	0.040
74/01/12	13 15		0.368	0.100	0.032	0.005K	0.015
74/02/09	13 15		0.340	2.100	0.105	0.005	0.020
74/02/22	12 10		0.368	0.650	0.055	0.005K	0.005K
74/03/09	13 20		0.312	0.900	0.040	0.005K	0.010
74/04/20	11 50		0.320	0.100K	0.020	0.005K	0.010
74/05/11	12 15		0.312	0.600	0.045	0.005K	0.005K
74/06/04	12 45		0.260	0.500	0.050	0.005K	0.005K

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

3105A2
37 11 10.0 082 29 40.0
POUND RIVER
51 7.5 HAYSI
1/JOHN W. FLANNAGAN RES.
FOOTBRIDGE OFF RT 631 2MI WOF ISOM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	11 40		0.100	0.520	0.039	0.007	0.020
73/08/11	12 20		0.088	0.340	0.027	0.005K	0.040
73/09/04	10 30		0.390	2.200	0.140		0.030
73/10/14	10 55		0.190	0.450	0.035	0.017	0.040
73/11/11	14 15		0.250	0.650	0.056		0.005K
73/12/08	11 05		0.330	0.700	0.060	0.008	0.020
74/01/12	12 15		0.500	0.500	0.048	0.005K	0.090
74/02/04	12 20		0.390	0.750	0.060	0.005K	0.010
74/02/22	11 05		0.288	0.600	0.065	0.005K	0.065
74/03/04	11 15		0.224	0.700	0.045	0.005K	0.045
74/03/22	09 30		0.390	0.800	0.045	0.005K	0.110
74/04/20	10 45		0.252	0.600	0.042	0.005K	0.005K
74/05/11	13 00		0.144	0.100	0.020	0.005K	0.005K
74/06/04	11 15		0.252	2.300	0.045	0.005K	0.052

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

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 51U581
37 07 17.0 082 26 25.0
CRANES NEST RIVER
51        7.5 HAYSI
T/JOHN W. FLANNAGAN RES.
AT BRDG ON RT 649 3 MI SE OF CLINTWOOD
11EPALES                    2111204
4                           0000 FEET  DEPTH
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DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	15 30		0.340	0.300	0.120	0.005K	0.005K
73/08/11	15 10		0.357	0.490	0.075	0.005K	0.020
73/09/04	12 30		0.220	0.720	0.350	0.005K	0.015
73/10/14	13 25		0.270	0.400	0.040	0.014	0.014
73/11/11	13 10		0.154	0.750	0.050	0.007	0.030
73/12/04	13 25		0.450	0.600	0.068	0.008	0.020
74/01/12	13 00		0.528	0.500	0.040	0.005K	0.110
74/02/04	14 00		0.440	1.200	0.085	0.005K	0.070
74/02/22	13 45		0.430	4.600	0.065	0.005K	
74/03/04	12 35		0.300	0.600	0.045	0.005K	0.030
74/03/22	14 26		0.440	1.100	0.050	0.005K	0.125
74/04/20	09 45		0.240	0.100K	0.025	0.005K	0.005K
74/05/11	15 00		0.012	0.300	0.025	0.005K	0.005
74/06/04	14 30		0.240	0.500	0.050		0.005

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

5105C1
37 09 15.0 082 26 44.0
HOLLY CREEK
51 7.5 HAYSI
T/JOHN W. FLANNAGAN RES.
AT END OF UNIMPROVED ROAD NE OF CLINT
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	10 50		1.620	3.500	0.680	1.200	1.650
73/08/11	10 40		0.940	3.700	1.160	0.510	0.770
73/09/09	12 45		0.590	4.600	1.700	0.900	2.700
73/10/14	13 45		1.680	4.400	2.200	2.100	2.300
73/11/11	09 25		2.100	4.400	2.000	1.320	2.400
73/12/08	13 45		0.600	5.000	1.800	0.756	1.450
74/01/12	11 00		0.870	1.500	0.184	0.060	0.280
74/02/08	14 30		0.960	3.200	1.050	0.380	1.000
74/02/22	14 00		0.870	3.000	0.610	0.250	0.860
74/03/09	13 45		0.770	3.200	0.945	0.525	1.475
74/03/22	10 20		0.800	1.200	0.250	0.080	0.430
74/04/20	10 10		0.924	3.500	1.250	0.810	1.150
74/05/11	15 20		1.600	3.200	1.720	1.050	1.800
74/06/04	10 25		1.340	3.800	1.500	1.200	1.650

STORET RETRIEVAL DATE 75/03/26

510501
37 10 46.0 082 28 58.0
GEORGES FORK
51 7.5 HAYSI
T/JOHN W. FLANNAGAN RES.
BRDG ON RT 621 APPROX .5MI N FREELING
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	12 00		0.560	0.560	0.094		0.020
73/08/11	12 12		0.260	0.350	0.040	0.012	0.020
73/09/04	13 15		0.330	4.600	1.160	0.012	0.055
73/10/14	10 50		0.125	0.550	0.025	0.011	0.025
73/11/11	09 35		0.010K	0.950	0.012	0.005K	0.005K
73/12/04	10 50		0.440	0.700	0.068	0.008	0.008
74/02/04	12 15		0.520	1.700	0.160	0.010	0.025
74/03/04	11 05		0.224	0.500	0.035	0.005K	0.010
74/04/20	10 35		0.240	0.300	0.030	0.005K	0.005K
74/05/11	12 50		0.028	0.400	0.035	0.005K	0.005
74/06/04	11 10		0.450	1.600	0.100	0.010	0.080

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

51051
37 11 05.0 082 28 05.0
BEARPEN BRANCH
51 7.5 HAYSI
T/JOHN W. FLANNAGAN RES.
BRDG ON RT 631 1/4 MI W OF ISOM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	11 20		0.189	0.600	0.031	0.018	0.050
73/08/11	11 40		0.066	0.780	0.042	0.006	0.025
73/09/09	10 10		0.120	1.050	0.450	0.010	0.025
73/10/14	10 47		0.023	0.600	0.029	0.020	0.020
73/11/11	10 35		0.176	1.300	0.052	0.008	0.010
73/12/08	10 40		0.140	0.500	0.028		0.007
74/01/12	12 00		0.252	0.600	0.052	0.008	0.020
74/02/09			0.224	0.900	0.060	0.010	0.010
74/02/22	11 00		0.192	0.900	0.045	0.020	0.040
74/03/09	10 55		0.112	0.700	0.050	0.005	0.010
74/03/22	13 10		0.176	2.000	0.065	0.005	0.030
74/04/20	11 30		0.084	0.500	0.015	0.010	0.015
74/05/11	12 45		0.020	0.300	0.090	0.005	0.005
74/06/09	11 30		0.132	0.200	0.015	0.005K	0.020

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/03/26

5105F1
37 13 10.0 082 27 02.0
CANE CREEK
51 7.5 HAYSI
T/JOHN W. FLANNAGAN RES.
OFF RT 611 1.25 MI SW OF BLOWING ROCK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/15	12 45		0.176	0.920	0.038	0.010	0.040
73/08/11	12 40		0.115	1.540	0.045	0.005	0.025
73/09/09	10 47		0.140	0.960	0.079	0.025	0.065
73/10/14	11 30		0.063	1.150	0.069	0.008	0.008
73/11/11	10 25		0.097	0.950	0.056	0.009	0.009
73/12/08	11 22		0.120	0.400	0.028	0.012	0.030
74/01/12	12 45		0.124	0.200	0.016	0.008	0.020
74/02/08	12 40		0.132	0.900	0.055	0.005K	0.005K
74/02/22	11 30		0.148	0.600	0.040	0.015	0.055
74/03/09	11 30		0.072	0.300	0.040	0.005K	0.010
74/03/22	09 52		0.096	0.900	0.050	0.005K	0.025
74/04/20	12 05		0.052	0.700	0.045	0.005K	0.005K
74/05/11	13 20		0.028	0.100	0.035	0.005K	0.005
74/06/09	11 05		0.112	0.700	0.055	0.005K	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED